

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Departments of Agronomy and Horticulture (Extension Work.)

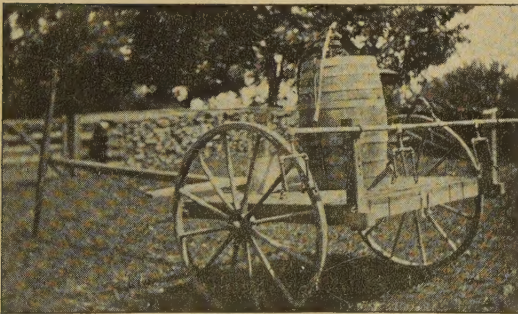
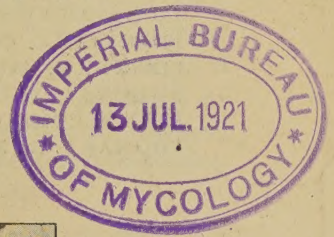
SPRAYING EXPERIMENTS.

I. SPRAYING FOR WILD MUSTARD.

By J. L. STONE.

II. THE DUST SPRAY

By JOHN CRAIG.



ALSO, AN OUTLINE OF CO-OPERATIVE
DEMONSTRATIONS AND TESTS
FOR 1904.

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

ORGANIZATION

OF THE CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT
STATION.

BOARD OF CONTROL THE TRUSTEES OF THE UNIVERSITY.

THE AGRICULTURAL COLLEGE AND STATION COUNCIL

JACOB GOULD SCHURMAN, President of the University.
FRANKLIN C. CORNELL, Trustee of the University
LIBERTY H. BAILEY, Director of the College and Experiment Station.
EMMONS L. WILLIAMS, Treasurer of the University.
JOHN H. COMSTOCK, Professor of Entomology.
THOMAS F. HUNT, Professor of Agronomy.

EXPERIMENTING STAFF

LIBERTY H. BAILEY, Director.
GEORGE C. CALDWELL, Chemistry.
JOHN HENRY COMSTOCK, Entomology.
HENRY H. WING, Animal Husbandry.
GEORGE F. ATKINSON, Botany.
JOHN CRAIG, Horticulture.
THOMAS F. HUNT, Agronomy.
RAYMOND A. PEARSON, Dairy Industry.
JAY A. BONSTEEL, Soil Investigation.
MARK V. SLINGERLAND, Entomology.
GEORGE W. CAVANAUGH, Chemistry.
JOHN L. STONE, Agronomy.
SAMUEL FRASER, Agronomy.
ROBERT S. NORTHROP, Horticulture.
JAMES M. VAN HOOK, Plant Pathology.
HERBERT H. WHETZEL, Plant Pathology.
JOHN W. GILMORE, Agronomy.
JAMES A. BIZZELL, Chemistry.
STEVENSON W. FLETCHER, Horticulture.
JOHN M. TRUEMAN, Animal Husbandry and Dairy Industry.
JAMES E. RICE, Poultry Husbandry.
CHARLES E. HUNN, Horticulture.

Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

EXPERIMENT STATION, COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,
ITHACA, N. Y., Feb. 27, 1904.

HON. C. A. WIETING, COMMISSIONER OF AGRICULTURE, ALBANY.

Sir: I submit herewith two reports on spraying,—the killing of wild mustard by means of a copper sulfate spray, and the use of dry or dust sprays in orchards. With these reports I also submit a schedule of coöperative demonstrations and experiments for 1904. I recommend that these three papers be published as Bulletin 216.

The extension experiments are largely demonstrational and educational. They are meant to attack living problems under the farmer's own conditions, and to instruct him in the methods to be employed in working out many of his own difficulties. In many instances the results of the experiments are well worth publication as a contribution to our knowledge of improved farm practice. In 1903 the number of extension experiments and demonstrations in charge of this College was approximately as follows :

Field crop work, about	300
Horticultural work	150
Milk tests	110
Cheese factories inspected	50
Poultry work	7
Entomological work	5
Miscellaneous	25

Respectfully submitted,

L. H. BAILEY,
Director.

Contents of this Bulletin.

- I. Spraying for Wild Mustard, page 105.
- II. The Dust or Powder Spray, page 109.
- III. Schedule of Coöperative Tests for 1904, page 118.

Bulletins 1903-4.

212. Second Report on Coöperation Records of the Cost of Producing Eggs.
213. Methods of Milking.
214. The Ribbed Cocoon-Maker of the Apple.
215. The Grape Vine Leaf-Hopper.



Examples of Extension Experiment Work with New York Farmers.

I. WILD MUSTARD: ITS DESTRUCTION BY SPRAYING WITH A SOLUTION OF COPPER SULFATE.

JOHN L. STONE.

In many sections of New York wild mustard is a great pest in the farmer's crops. Its greatest menace is in the spring-sown crops that do not receive tillage during growth, such as oats, barley, peas. Growing in these crops, it seriously affects the yield; and it is able also to mature its seeds, a part of which are scattered on the soil and a part of them go with the crop, perhaps to infest other fields. In inter-tilled crops it is held in check between the rows, but springs up in the rows and necessitates removal by expensive hand labor if the injury to the crop or the maturation of seeds would be prevented.

Wild mustard produces seeds very abundantly, and the seeds probably retain their vitality in the soil for many years, waiting for a favorable opportunity to germinate. Thus it becomes very difficult, if not quite impossible, to exterminate it by ordinary methods of cultivation if the land once becomes thoroughly infested.

I. THE EARLY EXPERIMENTS.

The credit of discovering that wild mustard can be destroyed by spraying with a solution of copper sulfate that will not injure several crops in which it grows, seems to belong to Bonnet, a Frenchman. The earliest reference to the subject that has come to my hand is in the Experiment Station Record, Vol. IX (1897) p. 1055 where the following extract is printed, "(Bul. Sta. Agron. Laon, 1897, pp. 68, 69), the announcement of Bonnet that a solution of copper sulfate would destroy wild mustard and wild radish when growing among cereals without injury to the latter, was tested at the station."

The announcement referred to seems to have led to much experimentation in the Old World. In the Journal of the Royal Agricultural Society of England 1899, pp. 767-775, Dr. J. A. Voelcker summarizes some 200 experiments that had come to his notice at that time. In the same year H. L. Bolley (In Proc. Soc. Prom. Ag. Sci. 1899, pp. 107-109) and F. T. Shutt (In Canad. Hort. 1879 p. 345) report the results of similar experimentation on this side of the Atlantic.

In these numerous experiments, several chemicals and these in various strengths of solution have been used, and their effects upon several weeds and also various farm crops have been reported. The following had been used at the rate of 25 to 100 gallons per acre:

Copper sulfate.....	2 to 6 per cent solution.
Iron sulfate.....	7 to 15 per cent solution.
Nitrate of soda.....	8 to 15 per cent solution.

All of these have proved more or less successful in destroying certain weeds and all injure or destroy certain crops. The general conclusion seems to be that copper sulfate in 2 to 5 per cent solutions sprayed at the rate of 40 to 50 gallons per acre is most generally satisfactory. Iron sulfate, though required in stronger solutions to be effective, is so much cheaper than copper sulfate that its use may sometimes be advantageous where large areas are to be covered.

II. THE CORNELL EXPERIMENTS.

Our own experiments and observations are confined to the use of copper sulfate solutions. These experiments were begun with the view (1) to test the effectiveness of this method of destroying wild mustard on New York farms and (2) to attract the attention of the farmers and lead them to avail themselves of this means to rid their lands of the pest. Now we hope to widen the scope of the investigation and ascertain whether similar methods may be successfully used to combat other troublesome weed pests; but it is thought wise to issue a small bulletin at this time to encourage the farmers to enter upon a crusade against the wild mustard.

Experiments on the College Farm.—There being no wild mustard growing on the college farm, seeds were secured in the spring of 1903 and small plats sown with alfalfa, clover, oats and peas, barley, and alone. Applications of copper sulfate solution were not begun till the mustard was in bloom. The applications were made with a knapsack sprayer, and it was very difficult to regulate the amount put on these small plats to a given rate per acre. It is probable that the rate of application was greater than 40 to 50 gallons per acre, as usually recommended. It was found that a 2 per cent solution thus applied killed mustard growing in each of the crops mentioned above without injury to the crop. A 3 per cent solution also killed the mustard and injured only the alfalfa, which, however, quickly recovered. Applications were made to some other farm crops to note the effect produced. A 2 per cent solution damaged field beans considerably and a 3 per cent solution nearly killed beans and potatoes and injured sugar beets. The beets, however, recovered and at harvest time were not distinguishable from those not treated. A 3 per cent solution rather liberally applied killed rape growing in oats without permanent injury to the oats.

Experiments at Mr. Mattison's Farm, Madison Co.—Oats were badly infested with mustard. The first trial was a failure because of heavy rain immediately following the application. Later the same field of 11½ acres was sprayed with a 3 per cent solution at the rate of 45 gallons per acre. The mustard was thoroughly exterminated. The oats were slightly blackened but recovered quickly and produced 63 bushels per acre. It was the opinion of the farm foreman that without the treatment the crop would have been so injured by the mustard as not to have produced over 15 bushels per acre, at least

on certain parts of the field. Aside from this gain in crop, the mustard was prevented from maturing seed.

Mustard growing in corn intended for the silo was also destroyed without injury to the corn; but subsequent cultivation brought other seeds to the surface so that they germinated after the corn was too large to permit of spraying, and hand-working had to be resorted to in order to prevent maturing of seeds.

Experiments at Mr. Palmer's Farm, Cayuga Co.—The crops, (sugar beets and corn) were badly infested, the beets being nearly hidden from view by the mustard, which was coming into bloom. The areas were sprayed with a 3 per cent solution, about one barrel per acre. The mustard was destroyed, except a few of the largest plants. The corn and beets were both slightly blackened but recovered quickly. No doubt the beets were considerably protected by the overgrowing mustard. A burdock hit by the spray was thought to have been killed, but it afterwards sprouted up from the crown.

Experiments of Mr. Atwater, Genesee Co.—(Reported by Mr. Driggs.) "He used the solution 10 pounds of copper sulfate to 40 gallons of water and applied with a sprinkling pot. In corn it killed the mustard but also injured the corn, but to what extent he could not tell. In the beans it killed both beans and mustard. In peas it also killed the mustard but did not injure the peas. It also killed burdock." No doubt this application made with a sprinkling pot was very much in excess of one barrel per acre, which accounts for much of the damage to the corn.

Experience of Winters and Prophet, Livingston Co.—These men produce large quantities of peas for their canning factory. Many of the fields have become badly infested with mustard, which greatly damages the crops. They have sprayed to destroy the mustard for three seasons. This season, 1903, they thus treated 300 acres. They always have used 10 pounds of copper sulfate to one barrel of water per acre. The results have been highly satisfactory except when rain has immediately followed the application, in which case it must be repeated. There has been no damage to peas, even when young. No other crop has been treated. The mustard is most effectively treated while young, as it is more susceptible then and later the crop protects it from the spray. It is a noteworthy fact that some fields treated in 1901 and 1902 did not have enough mustard in them in 1903 to make spraying necessary. This result is very pleasing, as it was scarcely to be expected that the seeds in these old-infested fields would be so reduced in amount in so short a time. For this work they used a one-horse six-row potato sprayer having a 100-gallon tank. It spreads the spray 18 feet wide and readily covers 20 acres per day.

III. GENERAL ADVICE.

The pump and all metal fittings should be of brass, as the copper sulfate solution is very destructive to iron. Wooden vessels should be used.

In connection with these and other experiments, it has been observed that the treatment is most effective if made in bright clear weather.

Young plants are more quickly and certainly destroyed than those in bloom.

If the weather is cloudy or the mustard rather mature, increase the strenghts of the solution or the amount used or both.

In the absence of a spraying outfit of the type illustrated in the frontispiece, a knapsack sprayer may be used for small undertakings, or a common barrel pump may be placed in a wagon and a spray nozzle at the end of a lead of hose may be swung from side to side behind the wagon by means of a rod four or five feet long.

The successful efforts at the destruction of wild mustard by means of the copper sulfate solution have awakened a wide interest in the question of combating other noxious weeds by means of this or other chemical agents. We hope to do more in this direction both at the College farms and in the coöperative experiments among the farmers of the State.

As offering helpful suggestions we append the following lists based upon our own observations and numerous reports from various sources :

Plants reported killed by copper sulfate solutions : wild mustard, wild radish, wild barley, penny grass (if young), shepherd's purse, wild buckwheat, lamb's quarter, ragweed, sow thistle, hemp nettle, bindweed, dock, dodder.

Plants reported severely injured : curly dock, black bindweed, dandelion, sow thistle and senecio.

Plants reported as not injured : wild rose, poppies, pigweed, spurge, corn-flower, field thistles, chamomile, couch grass, bentgrass and horsetails.

Crops that may safely be sprayed : all cereals, as wheat, rye, barley and corn ; the grasses ; peas ; sugar beets.

Crops that are killed or severely injured by the copper sulfate solution : beans, potatoes, turnips, rape.

It is desired to receive reports from farmers who may be led to experiment in the destruction of weeds by the use of chemicals. Comparatively few of these weeds grow on the College farms in sufficient abundance to afford opportunity for a satisfactory test. It is especially desired to secure data giving the effect of the various solutions on dodder growing in alfalfa or clover, ragweed and smartweed growing in oats or barley, devil's paint-brush growing in pastures, and wild carrot growing in meadows. We shall be glad to offer suggestions in regard to cases brought to our notice and so far as we are able to give personal attention to them.

GENERAL CONCLUSION : *Wild mustard growing with cereals or peas can be destroyed with a solution of copper sulfate, without injury to the crop. A 3 per cent solution (about 10 lbs. to the barrel, or 40 gallons, of water) at the rate of 40 to 50 gallons per acre, gives very satisfactory results.*

II. DUST OR POWDER SPRAYS.

A PRELIMINARY REPORT.

JOHN CRAIG.

Historical.—Both insecticides and fungicides have been applied in dry form for a number of years. Sulfur to control fungi, and pyrethrum to kill insects, have been applied with a bellows for many years and are still employed under glass or in other enclosures. In 1890, the Alabama Agricultural Experiment Station published a bulletin on the "Dry Application of Paris Green and London Purple for the Cotton Worm." Lodeman in the "Spraying of Plants," records the manufacturing for sale of the first American powder gun by Leggett as early as 1854. This was a hand machine, as were all others of the period. In 1895, the first horse-power dust-sprayer appeared and was aptly named the Sirocco dust sprayer. At the present time, there are several dust sprayers on the market. "Powder guns" are now quite generally used throughout the cotton-growing regions of the South.

Dust versus Liquid.—In spraying to control fungi and insects, the orchardists of the East have uniformly used a liquid spray. Water is the carrier. The method has many objections which need no urging upon the man who has made and applied Bordeaux mixture. In some regions, the use of liquid spray is almost impracticable on account of hilly ground and scarcity of water. It is in these regions (notably the Ozarks of Missouri) that the dust spray is most freely used and recommended. Here, lime is the carrier of the copper sulfate, Paris green, sulfur or whatever dry ingredient may be mixed with it. It is said by the advocates that powders are more easily made, transported and applied than liquids. Our experience does not endorse the assertion that they are more easily made, nor are they particularly agreeable. There is, however, no question about the ease of application, for when conditions are favorable the powder is quickly applied. Both liquid and powder are difficult to apply evenly when the wind is blowing. The powder does not adhere well when the leaves are dry, nor does it stick well on trees with smooth leaves, like the peach and pear, unless they are dampened by dew or fog. On roughish leaves, as apple and Japanese plum, it adheres surprisingly well; but, even then, it is better applied when the dew is on.

I. EXPERIENCE IN OTHER STATES.

Orchardists in Missouri have had more experience than others with dry sprays. In many instances, the hilly land and difficulty of securing water render the use of liquid sprays either exceedingly difficult or quite impossible. The dust form has been more or less in use for three or four years and by a few individuals for a longer period. The majority of those who have used dust sprays do not assert that it is as efficient a fungicide as liquid Bordeaux mix-

ure and perhaps not quite equal as an insecticide, but their contention is that this demerit is more than offset by the ease of application. W. L. Howard, instructor in horticulture in the Missouri Agricultural College, states that in 1902 the following results were secured in spraying for codling moth: "Unsprayed trees had 64 per cent affected; dust-sprayed, 36 per cent affected; and liquid-sprayed, 16 per cent affected. About the same results were secured in treating the cankerworm." This does not express a high degree of efficiency, but Mr. Howard believes that the dust spray in the average of years can be depended upon to do better. B. N. Johnson, of Atlanta, Ga., writes thus enthusiastically: "Dust spray is the only spray for plums. I was never able to land a crop of Japanese plums till I used dust. You can spray right up to picking time without injuring tree or fruit."

II. EXPERIENCE IN NEW YORK STATE.

1 *Dust and Liquid Spray Compared in Apple Orchard of J. Corwin Jacks, Batavia.*

The trees are about twenty-five years of age. They were sod-mulched last year. The variety, selected principally on account of the promise of a heavy crop and of susceptibility to scab, was Genesee Flower, a local sort closely allied to, if not identical with Monmouth Pippin. Four rows, with seven trees to the row, were selected for treatment. Two rows, on fourteen trees, were sprayed with dust on May 3d, and every week thereafter for six weeks. The two rows adjoining were sprayed with liquid Bordeaux on May 3d, and again on May 17th, two application only.

The unsprayed trees were separated from the sprayed by several rows and stood in ground which was cultivated last year and this year was cropped with clover.

The apples were graded by the apple packer (who purchased the orchard) into firsts and seconds, the first grade being approximately sound, while the seconds were made up of everything not absolutely culls, of which there were very few.

Yield of six average dust-sprayed trees.

No. 1, 48 bu. = 72.7 per cent.

No. 2, 18 bu. = 27.2 "

Percentage yield of the most productive tree dust-sprayed.

No. 1, 62.7 per cent.

No. 2, 37.2 "

Yield of six average liquid-sprayed trees.

No. 1, 35 bu. = 70 per cent.

No. 2, 15 " = 30 "

Percentage yield of best tree liquid-sprayed.

No. 1, 59.5 per cent.

No. 2, 40.5 "

The total yield of the unsprayed trees was not recorded, but the percentage of No. 1 and No. 2 fruit was obtained. No. 1 graded as 34 per cent of the whole, and No. 2 as 66 per cent.

In order to analyze the results more minutely, an average ungraded barrel of each lot was divided into four grades as follows :

- I. Of good size, free from blemishes.
- II. Seconds in size, free from blemishes.
- III. Wormy, or wormy and scabby.
- IV. Scabby only.

The following tabular arrangement gives the results secured by the examination made on this basis :

Treatment	Total	I	II	III	IV
Lot I. No. of apples	376	79	50	19	228
Unsprayed per cent	100	21.01	13.3	5.05	60.63
Lot II. No. of apples	431	124	175	10	122
Liquid-Sprayed per cent	100	28.76	40.6	2.32	28.32
Lot III. No. of apples	303	201	46	28	28
Dust-Sprayed per cent	100	66.3	15.2	9.25	9.25

The results shown in the foregoing table are fairly comparable with the records already given, if grades one and two, and three and four are combined. The differences which appear at first as striking will diminish by this method of comparison. In the first place, the showing the dust spray makes is considerably better than that expressed by the record of the whole crop. In selecting a barrel from the whole, it is quite possible that a sample rather better than the average might have been hit upon, because it was found that individual trees varied considerably. In the dust-sprayed barrel, an equal amount of fruit was injured by worms and fungus ; while in the liquid-sprayed barrel, only a little over two per cent was injured by worms, but twenty-eight per cent was affected by scab. This twenty-eight per cent is, however, small contrasted with the sixty per cent found in the barrel of unsprayed.

The following test made in the field illustrates the variability of individual trees. One bushel of liquid-sprayed apples picked at random from the tree contained 136 specimens of No. 1 and 102 specimens of No. 2 apples, commercial grade. Of these 102 specimens, 21 were affected by scab, being 8.8 per cent of the bushel ; and 34 per cent affected by worms or curculio, being 34 per cent of the contents of the bushel. Examining a bushel of dust-sprayed fruit selected at random in the field, we find 44 per cent No. 1 and 56 per cent of No. 2—strikingly different from the results stated above. Dividing the No. 2 specimens into scabby and wormy classes, it was found that 20 per cent of the bushel was affected by fungus, and 26 per cent by insects. These results show that conclusions should not be drawn from parts of an experiment of this kind because of the variability of individual trees and because of the difficulty, if not impossibility, of selecting a sample accurately representing the entire product.

Mr. Jacks makes the following general notes on this experiment :* "A tree of Genesee Flower situated some distance from the sprayed block standing in sod, unmulched and unsprayed, gave highly colored fruit, but at least 75 per cent are imperfect."

"Potatoes treated with this dust spray resisted blight much longer than those treated with liquid Bordeaux."

"We were greatly troubled with aphid on apple trees. The dust-sprayed trees were freer than the liquid-sprayed trees."

"Currant worms were subdued by one application of dust."

Cost of dust-spraying fourteen apple trees about twenty-five years old.

Dusted six times, one hour each application :

$$\begin{array}{rcl} 1 \times 6 & = & 6 \text{ hrs. at } 40\text{c. } \$2.40 \\ 42 \text{ lbs. dust} & & \text{" } 3\text{c. } 1.26 \end{array}$$

\$3.66

$$3.66 \div 14 = 26.1\text{c., rate per tree.}$$

Cost of liquid-spraying fourteen trees same age.

Two applications Bordeaux mixture, three hrs. each :

$$\begin{array}{rcl} 2 \times 3 & = & 6 \text{ hrs. at } 40\text{c. } \$2.40 \\ 56 \text{ gal.} & & \text{" } 1\frac{1}{4}\text{c. } .70 \end{array}$$

\$3.10

or at rate of 22c. per tree.

Dust formula used ; mixed mechanically :

- 10 lbs. powdered unslaked lime.
- 1 lb. dry Bordeaux.
- 1 " sulfur.
- 1 " Paris green.

2 Dust Spray on Peach Trees.

The special object of this test was to prevent the monilia, (soft rot or brown rot,) so injurious to early peaches. The experiment was conducted under the direction of the Horticultural Department by Hart Brothers, Lynbrook, Long Island, who carried out the details most faithfully. A row (1) of seventeen trees of Triumph was dusted on June 29 between one and two P. M. Rain followed next day, but traces of the dust still remained. July 2, two other rows (2 and 3) of seventeen trees, in addition to the first row, were dusted between five and six A. M. Rain followed the same evening. July 8, No. 2 dusted again. No rain followed for several days.

Results.—Rot appeared on July 9, increasing alike on sprayed and unsprayed for about a week. Hart Brothers say that "we found up to this time that each rotten fruit contained the larva of the curculio and that twenty-five per cent of the fruit of dusted and untreated trees had rotted." After this the rot spread very rapidly on the untreated trees and did not cease until

* See, also, an article by Mr. Jacks in Country Gentleman, March 3, 1904, p. 202.

all the fruit was destroyed. The behavior of the dust-sprayed trees was different. After the fruit affected by curculio had fallen (and now I quote from Hart Brothers' report) "the disease seemed to run out. The fruit did not rot for a week, neither did it ripen normally. With the beginning of August, frequent rains again occurred; rot once more appeared and all fruit on row 1 was destroyed. The fruit in rows 2 and 3 treated later than row 1 resisted the disease longer, but it was finally destroyed before mature. Twelve mature sound specimens were picked from these two rows—the only fruit saved. Later dustings might have saved more fruit." Hart Brothers state that in a normal season they believe that thorough application of dust Bordeaux may save perhaps fifty per cent of the crop.

My own opinion is that when we know more about the preparation of dust spray, it can be used with advantage in preventing plum and peach rot. It is also to be remembered that the applications were so infrequent as to have little affect in checking the attacks of curculio. Various reasons prevented weekly applications, which should have been made in order thoroughly to test the efficacy of the remedy as an insect and rot preventive.

3 *An experiment by Henry Lutts & Son, Youngstown, N. Y.*

The work in this test was conducted exclusively by Mr. Lutts, and the report given here is substantially his own record. Mr. Lutts dust-sprayed plums, peaches, pears and apples from four to six times. He is favorably impressed with the method. The results on his Greenings were exceptionally favorable, as also on Bartlett pears, both being smooth and fair and free from insect injury. With plums, there was some burning of the foliage where the dust was applied to wet leaves; but the work of the curculio, Mr. Lutts reports was prevented to a striking degree. The amount of rot was also diminished. It is to be remembered that these plums were dusted once a week for six weeks, beginning about the middle of June. On peaches, this peach-grower says, there was a marked difference at harvesting time between dusted and check trees in favor of the former. Mr. Lutts is, then, favorably impressed with the dust-spray method and intends to use it somewhat extensively this coming season. His impressions are based on rather careful observations, but not upon actual records gained by picking and measuring. He recommends that the powder be made and thoroughly dried some time before it is used, and that it be applied in the evening before the leaves are thoroughly moistened by dew. In other words he found it possible to burn plum leaves by dusting when they were loaded with moisture.

Some experiments carried on by Mr. C. E. Hunn, gardener of the Cornell University Horticultural Department, demonstrated that dust-spray was effective against aphids. A single application destroyed at least 75 per cent of the aphids on apple. But a single application was ineffective in preventing plum rot and in preventing the development of pear psylla.

III. FORMULAS FOR DUST SPRAY.

1 *Missouri formula.*

The following method of preparing Bordeaux powder is recommended by R. M. Bird, acting chemist of the Missouri Experiment Station, and quoted from Bulletin No. 60 of that station :

Materials required to make seventy pounds of a stock powder :

Four pounds of copper sulfate (blue stone).

Four pounds of good quick lime.

Two and a half gallons of water, in which to dissolve the copper sulfate.

Two and a half gallons of water, which is to be added to the quick-lime.

Sixty pounds of air-slaked lime which has been sifted through the fine sieve mentioned below.

Directions.—1 Break up into small lumps about seventy or eighty pounds of quick-lime and spread it out so that it will become air-slaked. When slaked and perfectly dry, sift it through the fine sieve (100 meshes).

2 Completely dissolve four pounds of copper sulfate in two and a half gallons of water. The easiest way is to suspend the sulfate in a coarse bag just below the surface of the water until it is dissolved.

3 Pour gradually two and a half gallons of water over four pounds of good quick-lime in such a manner as to slake it to the finest powder and give a good milk of lime solution ; let it cool.

4 Put sixty pounds of the sifted, air-slaked lime into a shallow box—one in which the material can be well worked with a hoe or shovel.

5 Pour the well stirred milk of lime and the copper sulfate solution at the same time into the third vessel containing the lime and stir it until the whole is thoroughly mixed. It will have a deep blue color and be thick. This is so finely divided that it will remain in suspension for hours.

2 *Maxwell formula.*

- 1 bbl. fresh lime.
- 25 lbs. copper sulfate.
- 5 “ concentrated lye.
- 25 “ powdered sulfur.
- 6 “ Paris green.

Spread lime in large shallow box, breaking it into as small lumps as possible. Dissolve the copper sulfate in six gallons boiling water ; also dissolve the lye in five gallons hot water. Keep separate. Sprinkle copper sulfate solution over the lime ; follow with lye solution. If the lime does not all crumble to a dust, use clear water to finish. Screen the lime through a fine sieve, rub the sulfur through the sieve, add the Paris green and thoroughly mix with lime. Lime should crumble to powder, not to granules.

Copper sulfate water must be used hot, or the copper will recrystallize. Mixing should be done out of doors or in separate building as lime in slaking becomes very hot.

IV. DUST SPRAY MACHINES.

Already there are a number of machines on the market, ranging in size from the small hand bellows to the horse-sized wheel-gearred machine. Some of them are crude, lacking in finish and durability and are somewhat expensive. The general principle of operation is to generate an air blast by means of revolving fans. Prices range from five to thirty dollars. Some of the smaller machines will prove serviceable for bush fruits, potatoes and the like. For orchard work, the machine should be of good construction and geared sufficiently high that the operator will not be called upon to operate the crank with undue rapidity.

Dust-spray machines may be purchased of the following manufacturers :
Leggett & Brother, New York City.

Kansas City Dust Sprayer Co., Kansas City, Mo.

J. J. Kiser, Stanberry, Mo.

Hillis Brothers, McFall, Mo.

Ozark Dust Sprayer Co., Springfield, Mo.

V.—DEDUCTIONS FROM THESE EXPERIMENTS ON DUST SPRAYS.

The labor and expense of applying dust sprays appear to be less than for sprays in liquid form. Six applications of dust spray were practically not more effective on apples than two applications of Bordeaux mixture ; neither did they cost more.

These experiments do not prove that insecticides and fungicides applied in dry form will prevent brown rot (*monilia*) of the peach and plum. Further experiments are needed to settle the question.

Dust or powder sprays should be applied in early morning or late afternoon. Damp, not wet conditions of atmosphere and tree are desirable if not essential. The powder must be strictly dry. Thoroughness of application is as necessary as with Bordeaux mixture.

Finally, it does not seem that, at the present time, there is any good reason why an orchardist who has reasonably level ground and available water supply and who is equipped with pumps for the application of liquid spray, should discard these, or even introduce the dry spray method. Under special conditions, it certainly has advantages ; but the conditions demanding the employment of dry sprays are usually lacking in the fruit districts of New York.

OUTLINE OF COÖPERATIVE DEMONSTRATIONS TO BE MADE IN 1904.

The following schedule gives a list of the demonstrations or experiments that it is proposed to make with New York farmers in the season of 1904. These experiments cover some of the most important of the newer problems that are just now pressing themselves on the attention of our farmers. The list contains enough subjects to offer to every farmer one or two for his particular study. We desire to correspond with any person in the state who may wish to take up any one or more of these subjects on his own place. If there are other important problems pressing for solution in any locality, we should be glad to consider them ; but in order to make the work efficient, it is necessary to limit our endeavors.

There are three purposes in this extension experiment work : (1) To illustrate or teach, — to instruct the coöperator in methods, to set him at the working out of his own problems, to bring him into touch with the latest discoveries and points of view. (2) To demonstrate in various parts of the State the value or the inefficiency of various new theories and discoveries, — to determine how far these newer ideas are applicable to local conditions. (3) To discover new truth, which may be worthy of record in bulletins : this is usually the least of the results that follow from such experiments because the experiments are not under perfect control nor continuously under the eye of a trained observer.

These 40 demonstrations and experiments are in seven categories, each category in charge of a specialist : I. Agronomy, J. L. Stone ; II. Plant Selection and Breeding, J. W. Gilmore ; III. Horticulture, John Craig ; IV. Entomology, M. V. Slingerland ; V. Animal Husbandry, H. H. Wing ; VI. Poultry Husbandry, J. E. Rice ; VII. Dairy Industry, R. A. Pearson. Correspondence should be addressed to the persons who have charge of these branches, at Cornell University, Ithaca, N. Y. Specify by number the experiments in which you are interested.

The general plan of work is mutual or coöperative, — the farmer to provide land and labor and to have the crop, the expert to give advice and supervision and, so far as possible, to inspect the work. In some cases, the college furnishes seeds and other materials. It does not furnish fertilizers. The benefit of the experiment or demonstration is expected to accrue mostly to the person on whose place the work is done.

It will be impossible, of course, to serve everyone. We shall take only as many experiments as we think we can handle satisfactorily. Persons who desire to engage in this work must apply quickly. Full instructions, together with blanks for the making of reports, will be sent to applicants.

I. AGRONOMY OR FIELD CROPS.

(J. L. STONE.)

No. 1. *Alfalfa*. (a) The experimenter to report the conditions existing, the manner of treating the crop and the successes and the failures met in his experience. The direct experiments suggested are

- (b) Seeding with and without a nurse crop ;
- (c) Treating a portion of the area with lime ;
- (d) When nodules are not found on the alfalfa roots, obtain some infected soil from a field where nodules are abundantly produced and scatter it over a portion of the area ;

(e) Apply stable manure to a part of the inoculated area and also to an uninoculated plat.

No. 2. *Oats*. A tests of three varieties of oats from selected seed. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

No. 3. *Fertilizers*. A test with nitrogen, phosphoric acid and potash singly and in combinations, eight plats 1-20 to 1-10 acre each. The set comprises 260 lbs. of chemicals that cost the experimenter four dollars.

No. 4. *Potatoes*. (a) Test of varieties. Five pounds of each of three selected varieties will be furnished by the college. To be planted on a definite area and crop weighed.

(b) Cultural experiment. A comparison of the Cornell method with your own as described in Circular No. 18.

No. 5. *Sunflower* in corn for silage. Seed will be furnished for a test.

No. 6. *Soy beans*. A test of several varieties with a view to determine

- (a) Their grain producing qualities,
- (b) Their forage producing qualities,
- (c) Their green manurial qualities.
- (d) Adaptation to growing with corn to improve the quality of silage.
- (e) Is artificial inoculation necessary?

(Experiments at the Cornell station indicate that this desirable natural stock food may be grown to advantage in New York.)

No. 7. *Field beans*. A test of several leading sorts. About one pint of seed of each variety furnished by the College.

No. 8. *Buckwheat*. (a) Variety test. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

(b) Cultural experiment. Plow one plat early and harrow frequently till seeding time. Plow another plat just before seeding.

No. 9. *Winter vetch and rye*. A test of the combination as a cover crop, which may be used as a soil renovator, as early spring pasture, as a forage crop or for the production of seed.

No. 10. The destruction of certain weeds such as wild mustard, alfalfa

dodder, devils paint brush, wild carrot, rag weed, smartweed, etc., by spraying with chemical solutions.

No. 11. *Testing the effect of lime on soils.*

No. 12. *The inoculation of legumes by means of artificial cultures.*

No. 13. *The renovation of pastures and meadows without plowing.*

II. PLANT SELECTION AND BREEDING.

(J. W. GILMORE.)

No. 20. *Potatoes.* An experiment in selection for the purpose of increasing the yield.

No. 21. *Potatoes.* An experiment to determine the affect of different soils in different localities upon the yield and quality.

No. 22. *Oats.* An experiment in selection for the purpose of increasing the yield.

III. HORTICULTURE.

(JOHN CRAIG.)

No. 30. *Orchard cover-crops.* 3 plats. A comparison of the values of hairy vetch, cow peas and mammoth clover, in apple, plum, pear or peach orchard. All plats in cover-crop experiments $\frac{1}{8}$ acre in extent. Keep soil thoroughly stirred from spring until middle of July, when seed should be sown. Seed furnished by the College.

No. 31. *Orchard cover-crops.* 3 plats. A comparison of cover-crop values of alfalfa and mammoth clover sown separate and mixed.

No. 32. *Spraying experiment.* Compare lime and sulfur with Bordeaux mixture as a fungicide. Prepare according to directions given in Spray Calendar.

No. 33. *Dust spray vs. Bordeaux mixture.* (A limited number of experiments.)

No. 34. *Spraying to prevent peach and plum rot.* Ammoniacal copper carbonate. Spray twice as fruit is ripening. Spraying material furnished by the College.

No. 35. *Thinning fruit.* Conduct careful tests on early apples, peaches and plums.

No. 36. *Strawberry.* Variety test.

No. 37. *Raspberry.* Variety test.

IV. ENTOMOLOGY.

(M. V. SLINGERLAND.)

No. 40. *Winter sprays for pear psylla.* Tests of lime, salt and sulfur wash and whale oil soap solution applied in March. Special directions sent to each experimenter.

No. 41. *Poison sprays for plum curculio.* Experiments with arsenate of

lead and arsenite of lime sprays. Specific directions and arsenate of lead furnished by the College.

No. 42. *Spraying for grape root-worm.* Experiments with arsenate of lead spray to poison the beetles. Specific directions as given in Bulletin 208 or the Spray Calendar. (Bul. 217.)

No. 43. *Spraying and timely cultivation for the rose-chaffer.* Specific advice in regard to time to cultivate to kill the pupæ, and directions given for spraying with arsenate of lead to kill the beetles. Poison furnished by the College.

V. ANIMAL HUSBANDRY.

(H. H. WING.)

No. 50. *Cattle.* The information sought will include (a) period of gestation of cows, (b) sex of offspring, (c) weight of offspring, at birth, (d) in case where calves are raised or vealed weight at four, six and eight weeks of age. To those who undertake this work cards for making reports will be furnished on request.

No. 51. *Swine.* The information asked for will include (a) period of gestation, (b) number of offspring, (c) sex of offspring, (d) weight of litter and if possible of each individual at birth. To those who undertake this work, cards for making reports will be furnished on request.

No. 52. *Experiments on the Hegelund method of milking* will be continued. (See Cornell Univ. Agr. Exp. Sta. Bull. 213.)

VI. POULTRY HUSBANDRY.

(J. E. RICE.)

No. 60. *Importance of supplying grit to fowls* to determine the amount consumed, the best kind, and the effect upon the quantity of eggs, hardness of shell, and in preventing "egg eating."

No. 61. *The importance of meat in a ration for egg-production*, and to observe the effects upon number, size and fertility of eggs and vitality of chickens.

No. 62. *The value of a ration of whole grain* as compared to the same ration part ground and fed dry or fed in a "hot mash."

No. 63. *Comparative value of hot mash* and the same feed fed dry.

No. 64. *Breed test.* A comparison of pens of the same number of individuals of different varieties of similar age.

No. 65. *Study of poultry houses.*—To determine temperatures inside and out, also dampness, and to observe comparative value of different types and styles of construction. For example,—with and without hooded roosts. With and without curtains in front of windows; with and without double walls or gables stuffed with straw. With and without various kinds of ventilators, cloth windows or glass windows, etc., etc.

No. 66. *Feeding chickens whole grain versus soft food*, or rations with and without some form of meat or skimmed milk.

No. 67. *Trap nest records* of each hen in the flock. (Plans for trap will be furnished free.)

VII. DAIRY INDUSTRY.

(R. A. PEARSON.)

No. 80. *Churning*. Complaint is often heard about the difficulty of churning cream from the milk of a cow far advanced in the period of lactation, sometimes it is said such cream cannot be churned.

Churn separately the cream from "stripper" milk in the usual manner. Carefully note length of time of churning, and temperatures 18 or 12 hours, five hours, one hour, and five minutes before churning.

As soon as practicable, churn another lot of similar cream but make sure that it is well ripened at 70° F. and held at 62° F. at least five hours before churning and churn it at 62°. Compare results with previous churning. Determine in succeeding churnings the advantages and disadvantages of higher and lower temperatures for ripening and churning.